Homework 1 Polymer Physics
December 17, 2018

1) The following plot shows the behavior of melting point, T_M, as a function of the log of molar mass.

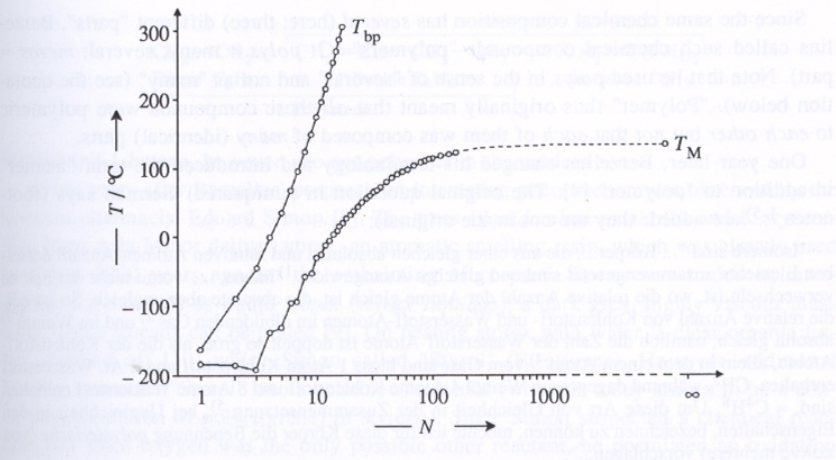


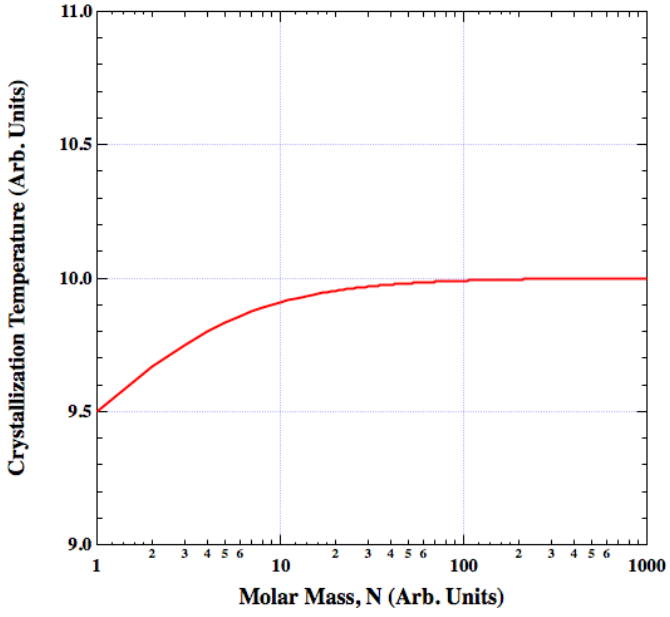
Fig. 1-1 Dependence of melting temperatures, T_M, and boiling temperatures, T_{bp}, of alkanes and poly(methylene)s, $H(CH_2)_NH$, on the number N of methylene groups per molecule [1, 2].

a) Give the explanation for the shape of the melting point curve that was given in class.

b) The Hoffman-Lauritzen Equation (a.k.a. Gibbs Thompson Equation) under the assumption that the crystal thickness, t, is proportional to molar mass, N for extended chain crystals (so t ~ N) yields the following dependence of crystallization temperature versus molecular weight.

$$N \sim t = \frac{2\sigma_e T_\infty}{\Delta H_f (T_\infty - T_c)}$$

$$T_c = K_1 - \frac{K_2}{N}$$



Does this plot support or argue against the explanation you gave in part a? Why?

2) The Couette viscometer is composed of a cup and a bob as shown in the figure below.

The bob spins with an angular velocity ω (radians per second), and a torque T (Newton meter) is measured at point 2. The angular velocity is defined in terms of the tangential velocity, v(r) and the radius r by $\omega = v/r$, and the torque is defined in terms of the force F(r) as $T = F*r$.

a) If the bob has a radius R, a length of L and the gap between the bob and the cup is ΔR, write an expression for the Newtonian viscosity based on a set angular velocity ω and a measured torque T, under that assumption that $\Delta R <<< R$.

b) For a non-Newtonian, power-law fluid the assumption that $\Delta R <<< R$ isn't valid since the fluid is extremely sensitive to variation in the shear rate across the gap caused by the curvature of the surfaces. How can a constant shear rate across the gap be achieved in a rotational viscometer?

c) Sketch the log of the log of the viscosity versus the log of the shear rate for a typical polymer melt and explain how the relaxation time, τ^*, for entanglements can be obtained from this plot.